What is claimed is:

1. A method to form a multilayer metal structure for improving adhesion to an underlying diffusion barrier layer, the method comprising the steps of:

a) forming a thin high-resistive metal layer, whereby this high-resistive layer serves to improve the adhesion of metal to the underlying diffusion barrier layer;

b) treating the thin high-resistive metal layer to reduce the resistance of the thin high-resistive metal layer, whereby the treatment step improves the conductivity of the high-resistive metal layer without destroying the adhesion property; and

c) forming a low-resistive metal layer, in which the resistivity of the low-resistive layer is lower than the resistivity of the treated high-resistive layer, whereby this layer serves to carry the electrical current with minimum electrical resistance.

2. A method as in claim 1 in which the higher value in resistivity of the high-resistive metal layer is due to the presence of oxygen.

3. A method as in claim 1 in which the steps a) and b) are repeated a plurality of times before continuing to step c) to achieve a desired thickness.

4. A method as in claim 1 in which the total thickness of the treated high-resistive metal layer is less than 5 nm.

5. A method as in claim 1 in which the resistivity of the high-resistive metal layer is between 10 to 500 $\mu\Omega$-cm.

6. A method as in claim 1 in which the resistivity of the treated high-resistive metal layer is between 3 to 400 $\mu\Omega$-cm.

7. A method as in claim 1 in which the thickness of the high-resistive metal layer in step a) is less than one monolayer for ease of treatment in step b).

8. A method as in claim 1 in which the formation of the high-resistive metal layer in step a) is by adsorption of a metal-carrying precursor.

9. A method as in claim 1 in which the high-resistive metal layer is deposited by the chemical vapor deposition method employing a combination of process precursors and process conditions to achieve a resistivity between 10 to 500 $\mu\Omega$-cm.

10. A method as in claim 9 in which the process precursors are exposed to a plasma power source, whereby this exposure serves to break up the precursors for easier incorporation of impurities into the high-resistive metal layer.

11. A method as in claim 9 in which the process precursors comprises a liquid metal precursor and an oxygen-contained precursor, whereby the liquid metal precursor serves to deposit a metal layer, and the oxygen-contained precursor serves to incorporate oxygen into the deposited metal layer to achieve the resistivity between 10 to 500 $\mu\Omega$-cm.

12. A method as in claim 11 in which the oxygen-containing precursor is a precursor comprising an oxygen species, the oxygen species being selected from a group consisting of O_2, N_2O, NO_2, air, water vapor, alcohol vapor, OH ligand, and chemicals containing OH ligand, and chemicals releasing OH ligand upon annealing.

13. A method as in claim 1 in which the treating of the high-resistive metal layer is by the method of oxygen gettering.

14. A method as in claim 1 in which the treating of the high-resistive metal layer is by the reaction of plasma hydrogen.

15. A method as in claim 1 in which the treating of the high-resistive metal layer is by the introduction of organic compounds to reduce metal oxide to the metal and volatile organic by-products.

16. A method as in claim 1 in which the treating of the high-resistive metal layer is by the introduction of a gettering metal precursor, the gettering metal is selected from a group of metals wherein its oxide conducts electricity.

17. A method as in claim 1 in which the treating of the high-resistive metal layer is by the introduction of an alloying metal precursor, the alloying metal is selected from a group of metals that forms an alloy with metal oxide such that the alloy is not non-conducting of electricity.

18. A method as in claim 1 in which the low-resistive metal layer is deposited with the resistivity less than 3 $\mu\Omega$-cm.

19. A method as in claim 1 in which the low-resistive metal layer is deposited by the electrochemical deposition method.

20. A method as in claim 1 in which the low-resistive metal layer is deposited by the chemical vapor deposition method.

21. A method as in claim 1 in which the low-resistive metal layer is deposited sequentially by

the chemical vapor deposition method and then by the electrochemical deposition method.

22. A method as in claim 1 comprising a further step, preceding step a): of

c) depositing the underlying diffusion barrier structure on a substrate, whereby the diffusion barrier structure serves to prevent the diffusion of metal into the substrate.

23. A method to form a multilayer metal structure for improving adhesion to an underlying diffusion barrier layer, the method comprising the steps of:

a) forming a thin high-resistive metal layer, whereby this high-resistive layer serves to improve the adhesion of metal to the underlying diffusion barrier layer;

b) treating the thin high-resistive metal layer to reduce the resistance of the thin high-resistive metal layer by introducing organic compounds to reduce metal oxide to metal and volatile organic by-products, whereby the treatment step improves the conductivity of the high-resistive metal layer without destroying the adhesion property; and

c) forming a low-resistive metal layer, in which the resistivity of the low-resistive layer is lower than the resistivity of the treated high-resistive layer, whereby this layer serves to carry the electrical current with minimum electrical resistance.

24. A method to form a multilayer metal structure for improving adhesion to an underlying diffusion barrier layer, the method comprising the steps of:

a) forming a thin high-resistive metal layer, whereby this high-resistive layer serves to improve the adhesion of metal to the underlying diffusion barrier layer;

b) treating the thin high-resistive metal layer to reduce the resistance of the thin high-resistive metal layer by introducing a gettering metal precursor, the gettering metal being a metal wherein its oxide conducts electricity, whereby the treatment step improves the conductivity of the high-resistive metal layer without destroying the adhesion property; and

c) forming a low-resistive metal layer, in which the resistivity of the low-resistive layer

is lower than the resistivity of the treated high-resistive layer, whereby this layer serves to carry the electrical current with minimum electrical resistance.

25. A method to form a multilayer metal structure for improving adhesion to an underlying diffusion barrier layer, the method comprising the steps of:

a) forming a thin high-resistive metal layer, whereby this high-resistive layer serves to improve the adhesion of metal to the underlying diffusion barrier layer;

b) treating the thin high-resistive metal layer to reduce the resistance of the thin high-resistive metal layer by introducing an alloying metal precursor, the alloying metal is selected from a group of metals that forms an alloy with metal oxide such that the alloy is not non-conducting of electricity, whereby the treatment step improves the conductivity of the high-resistive metal layer without destroying the adhesion property; and

c) forming a low-resistive metal layer, in which the resistivity of the low-resistive layer is lower than the resistivity of the treated high-resistive layer, whereby this layer serves to carry the electrical current with minimum electrical resistance.